



Monterey Bay National Marine Sanctuary

INTRODUCTION

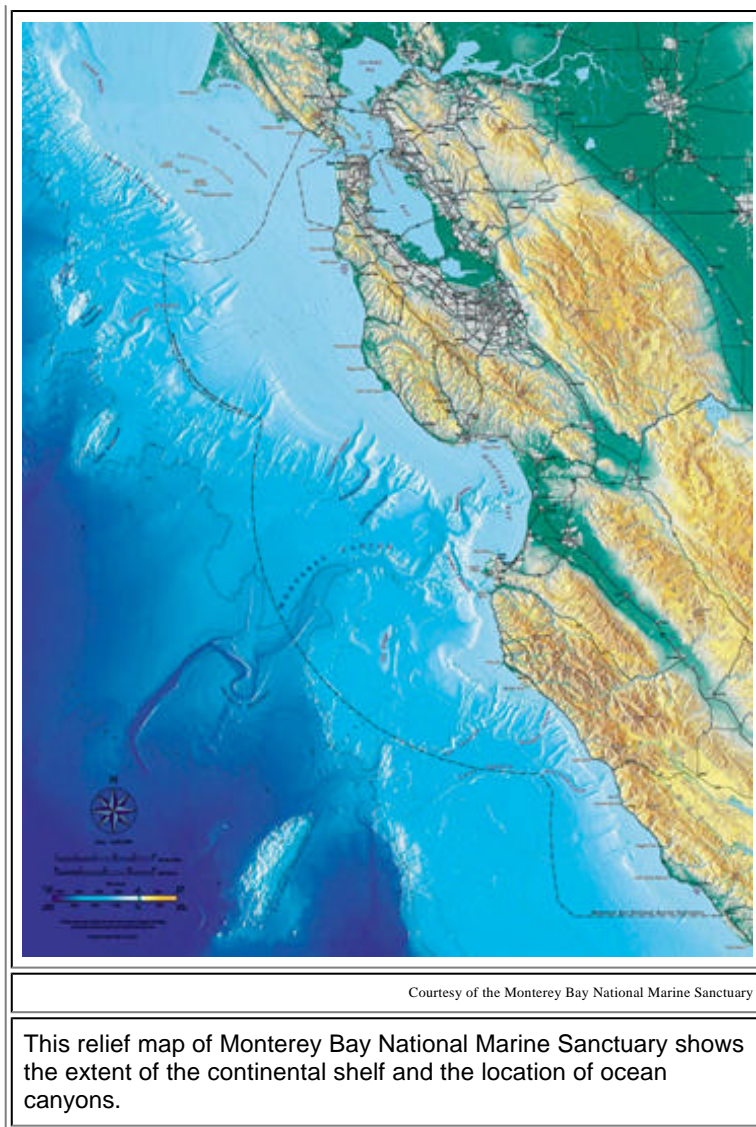




Kenneth W. Fink, Photo Researchers

Monterey Bay National Marine Sanctuary starts at the shoreline and extends up to 50 km (31 miles) into the ocean.

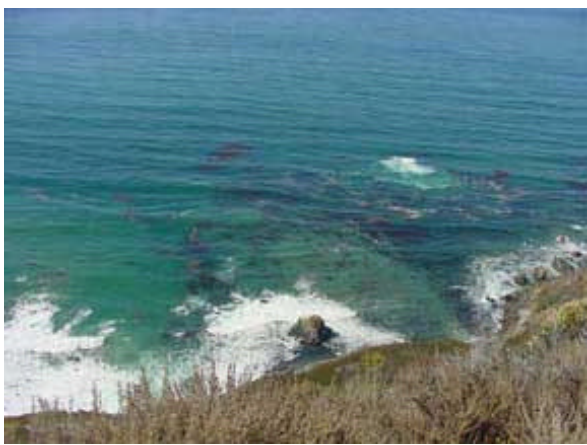
Monterey Bay National Marine Sanctuary is one of 13 national marine sanctuaries. A marine sanctuary is like a national park in the ocean. Monterey Bay is the largest of all the marine sanctuaries, covering 13,730 square kilometers (5360 square miles). The sanctuary is in the Pacific [temperate ocean](#). It stretches from San Francisco to Santa Barbara, and extends from the shore into the ocean an average of 50 kilometers (31 miles).



In the 1800s Americans recognized the need to protect certain areas of the United States from development and to preserve them in their natural state. This led to the establishment of Yellowstone National Park in 1872, the National Forest Service in 1905, and the National Park Service in 1916. The oceans and coastal waters were not included in either of these systems. It was not until 1969, when a huge oil spill devastated the coastline of southern California, that the need to protect North America's coastal waters came to public attention.

The national marine sanctuary system was established in 1972. A sanctuary protects ocean waters, the habitats in them, and the local cultural history. Activities like dumping waste and drilling for oil are not allowed. Activities like fishing and recreation are permitted but regulated. In 1977 Monterey Bay was included in a study to designate it as a sanctuary. People fought to include the central coast of California to protect it from oil drilling. Monterey Bay National Marine Sanctuary was designated by congress on September 18, 1992, as the 11th and largest sanctuary in the system. As of 2000, with the designation of Thunder Bay in the Great Lakes, there are 13 national marine sanctuaries in the United States.

The central coast of California supports a unique ecosystem known as the [kelp forest](#). Several varieties of [kelp](#) (algae) grow from the rocky seabed to the ocean surface. These "forests" of kelp are home to fish, [sea otters](#), [snails](#), [sea urchins](#), [crabs](#), and many other living things. The kelp forest is one of the natural features people were hoping to protect by founding the sanctuary.



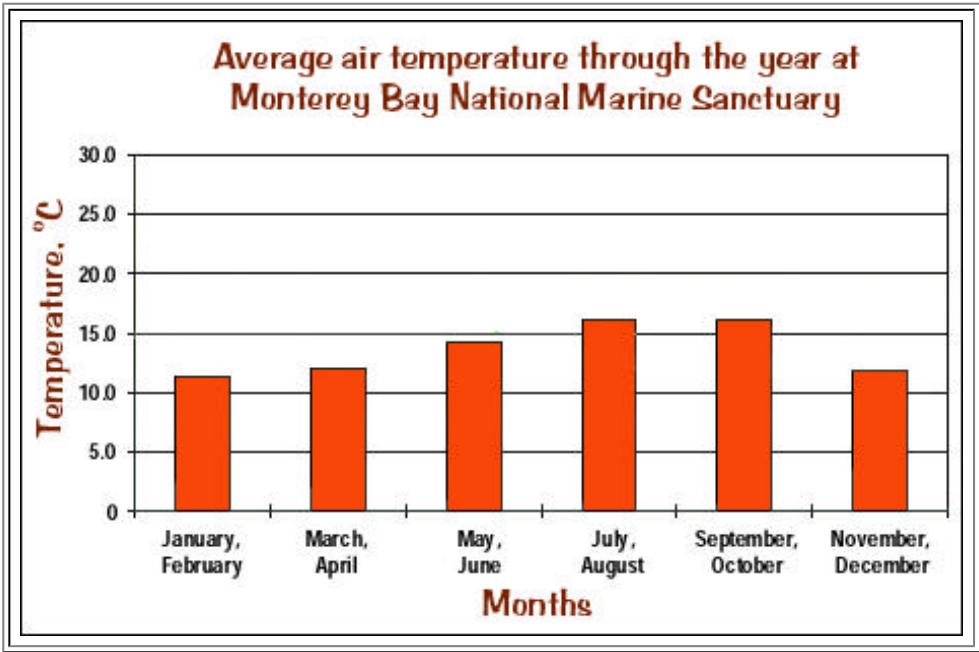
Courtesy of John Schexnayder

Patches of kelp forest often occur close to shore.

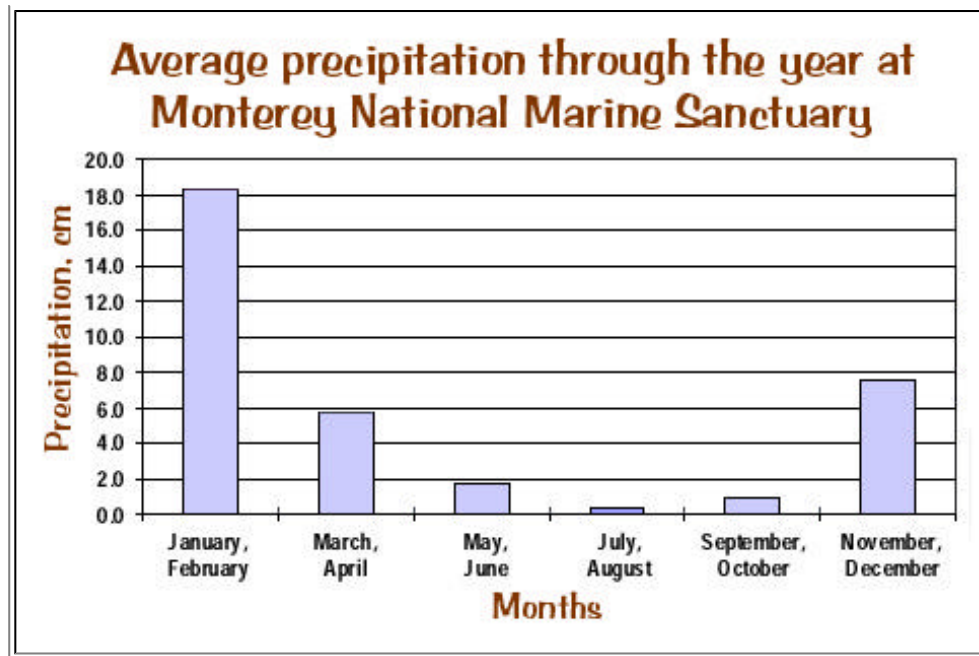
Monterey Bay National Marine Sanctuary also has other coastal and near-coastal marine habitats. These include sandy beaches, coastal dunes, rocky intertidal, and deep ocean. In the spring, water from deep underwater canyons moves up to the surface. The water is cold and contains lots of nutrients that help [phytoplankton](#) grow. This movement of water to the ocean surface is called upwelling. Upwelling brings nutrients up to the layer of water that has sunlight, resulting in high productivity by phytoplankton in Monterey Bay.

ABIOTIC DATA

The ocean is influenced by abiotic factors in the air and water, and along the ocean bottom. Monterey Bay National Marine Sanctuary is affected by ocean currents, nutrient upwelling, and El Niño events. The shape of the seabed and the strength of waves are also important.



A typical day during summer and early fall at Monterey Bay National Marine Sanctuary is cool, with air temperatures of 16–18°C (61–64°F). At this time of year, winds blow from the northwest at about 4–4.5 meters/second (8–9 knots). The skies may be somewhat cloudy, but rain rarely falls. This is the dry season at Monterey Bay.



The wet season is between November and early April. Different amounts of rain fall at different places in Monterey Bay National Marine Sanctuary. For instance, at Monterey Bay 48 centimeters (19 inches) of rain falls, while Santa Cruz, just 40 kilometers (25 miles) north, gets 150 centimeters (60 inches). During the wet season, temperatures are cooler but not extremely cold, usually about 10–13°C (50–55°F). A gentler wind blows from the west in the wet season, 2–3 meters/second (4–6 knots).

Two ocean currents come into Monterey Bay: the California Current and the California Undercurrent. The California Current is moving water from the [subarctic ocean](#) near Alaska. This water is cool and not very salty. The California Undercurrent moves water up from the [tropical ocean](#). This water is warm and salty. The strength of these currents compared to one another changes during the year. In the fall and winter, the undercurrent is stronger, so the overall current in Monterey Bay National Marine Sanctuary is northward. In the spring and summer, the California Current is stronger. The overall current in this season moves water south.

This mix of subarctic and tropical waters affects the water temperature and salinity at Monterey Bay. Usually the water there has a salinity of 0.033%. Average ocean water has a salinity of 0.035%. Streams flowing into the ocean can also affect salinity. The water is warmest in the early fall, 15°C (59°F), and coolest in the late winter, 11°C (52°F). Deep water is cooler.

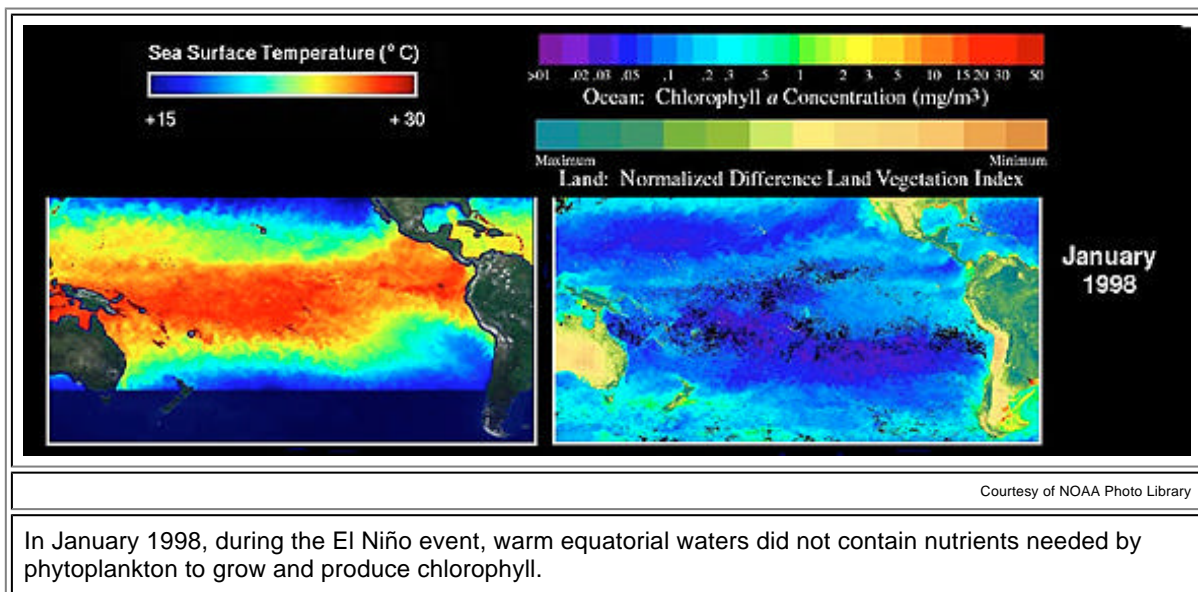


Courtesy of NOAA Photo Library

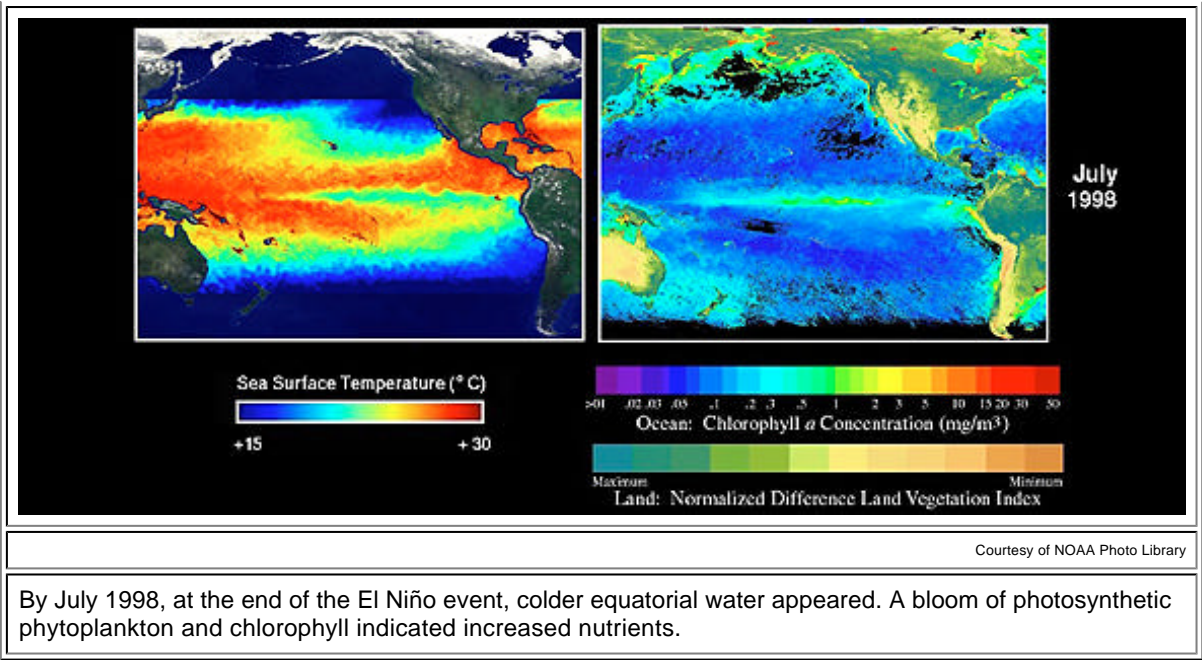
Light levels are low on the ocean bottom in a kelp forest.

Light does not penetrate water easily. For this reason, the amount of light on the ocean's surface is not the same amount that hits the ocean floor. The top few meters has a lot of light and is called the photic zone. The amount of light decreases with depth. In some areas, light can penetrate as deep as 900 meters (3000 feet). In a kelp forest, the light cannot go as deep because the kelp is so dense. The area that does not have light is called the aphotic zone.

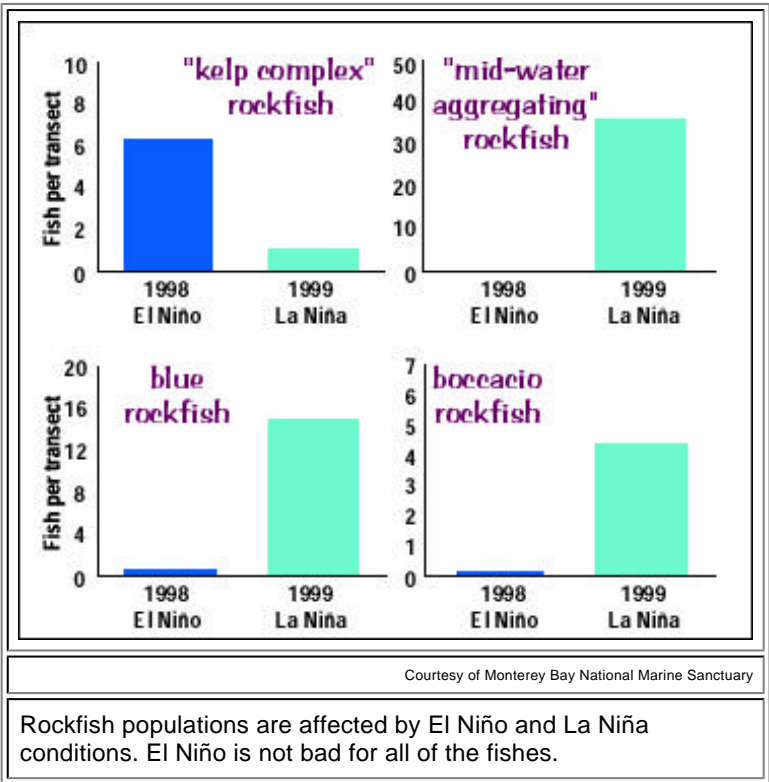
When northwest winds blow on the surface of the ocean, they cause deep water upwelling. Upwelling brings cold, nutrient-rich water to the surface from 25–300 meters (80–1000 feet) below. The surface temperature may drop as much as 5°C (9°F) with upwelling. Nutrients, like nitrates, phosphates, and silicates, are brought up to the photic zone. Here they are available to organisms that photosynthesize. Upwelling is strongest in the spring.



Every 3 to 7 years, El Niño disrupts the ocean-atmosphere system in the Pacific Ocean. El Niño, which usually occurs in the winter, is caused by a change of current patterns near the equator. Weaker equatorial winds cannot draw up the colder, nutrient-rich water from deep in the ocean. This allows the warmer, nutrient-poor surface water to flow in the currents that feed Monterey Bay.



During an El Niño year, the water at Monterey Bay National Marine Sanctuary and along the entire west coast of the United States is unusually warm, which results in higher rainfall and more storms. Some years with very strong El Niño events were 1982–1983 and 1997–1998. The year following an El Niño usually is a La Niña year. During La Niña, the water is cooler than normal.



The ocean floor in Monterey Bay National Marine Sanctuary is mostly hard granite. Some sandy ocean floor is found in coves closer to shore. Within the sanctuary, the ocean floor drops gradually at first. This shallow area is the continental shelf. As you move farther from land, the ocean floor drops steeply onto the abyssal plain. The sanctuary also has underwater canyons up to 4000 meters (13,000 feet) deep. Monterey Canyon is the deepest, and it runs right out from Monterey Bay. Because these deep canyons are so close to shore, deep-ocean creatures can be observed near the coast, making Monterey Bay a unique area.

BIOTIC DATA

Monterey Bay National Marine Sanctuary is dominated by the ecosystem called a [kelp forest](#). The trees in this forest are actually species of algae commonly known as kelp. In Monterey Bay National Marine Sanctuary there are two dominant kinds of kelp. The more common species is [giant kelp](#). It prefers sites with calm water where each individual kelp can live for up to 10 years. Giant kelp can grow as much as 0.6 meter (2 feet) a day when it gets enough light. The other species is bull kelp. It grows mostly in exposed areas with plenty of water motion. It has an annual life cycle. Because these kelp prefer different amounts of water motion, giant kelp might be more abundant in calm years, while bull kelp would dominate in years with rough surf.


Like forests on land, kelp forests need sunlight. They grow in the photic zone. Kelp forests usually are found in water between 2 and 30 meters (6 and 100 feet) deep. Also, like terrestrial forests, kelp forests have patterns of seasonal growth. In the spring, juvenile kelp grow quickly. By summer, there is a lush canopy of kelp. In the fall, growth slows, and the kelp fronds become ragged and torn, partly because of the invertebrates that feed on them. In the winter, when the surf is higher, kelps tear loose from the ocean floor. Giant kelp grows very slowly in the winter, and bull kelp dies.

Kelp requires cold temperatures to reproduce sexually, which starts the cycle over each year. During El Niño years, however, the temperatures are higher than normal, so the kelp may not be able to reproduce. For giant kelp, this results in older, more fragile kelp throughout the kelp forest during the following year. Bull kelp would die back completely if it could not reproduce.



The kelp forest can be divided into layers that support different communities of organisms—substrate, midwater, and canopy. The substrate layer is at the bottom, where the [kelps](#) are attached to rocks with rootlike structures called holdfasts. [Abalones](#), [bat stars](#), [brittle stars](#), and [sea urchins](#) are a few of the animals found in the substrate layer. [Lobsters](#) and [hermit crabs](#) hide in the rocks and scavenge for bits of detritus.

The midwater layer is where the leaflike fronds of kelp are suspended in the water. [Turban snails](#) and [purple-ringed top snails](#) cruise up and down the fronds in search of food. Fish, such as [garibaldi](#), [sheepheads](#), and [giant kelpfish](#), swim among the fronds. The [señorita](#) fish's slender body is easily camouflaged by the kelp fronds. [Kelp crabs](#) climb up and down the kelp stipe, adding bits of kelp to their carapace for camouflage.

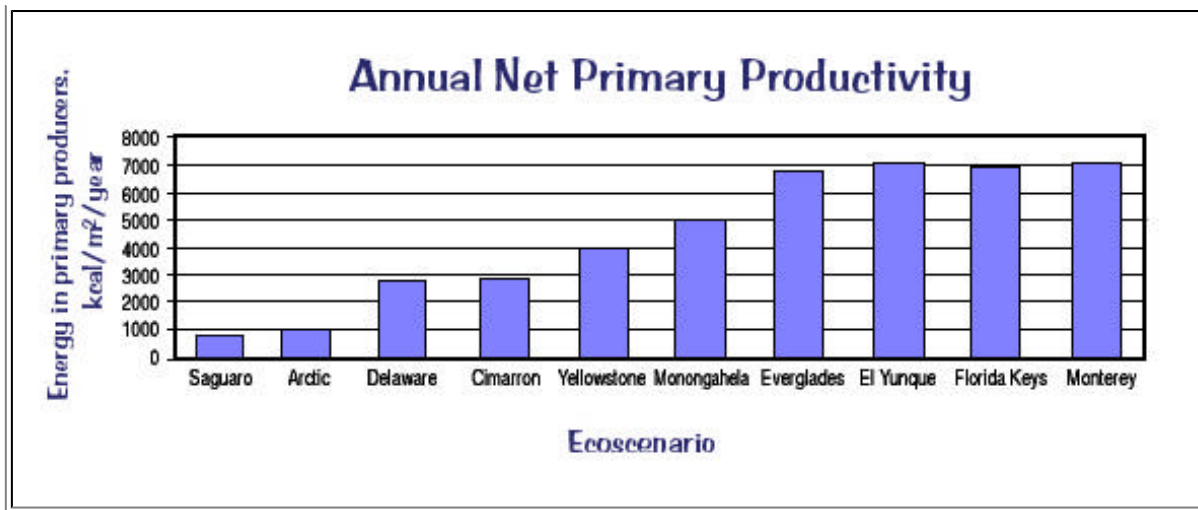
	
Art Explosion	Art Explosion
Nudibranchs, related to octopuses and snails, graze on kelps.	Hermit crabs scavenge for detritus for food and abandoned shells for shelter on the rocky substrate.

The canopy layer is closest to the surface. Here, the kelp blades bob on the surface waves. Colorful [nudibranchs](#) (*NEW•duh•braynks*) slide across the kelp blades. Nudibranchs can be found in the substrate layer as well. Some kelp fronds are covered with small encrusting [bryozoans](#). [Zooplankton](#) and [phytoplankton](#) float in the water near the surface, moving with the current.

The [sea otter](#) makes its home in the canopy. The sea otter is a marine mammal up to 1.2 meters (4 feet) long and related to weasels. It is very rarely seen out of the water. To keep warm in the cold Pacific waters, otters have extremely dense fur, which traps air between individual hairs. This keeps the otter's skin dry as it dives to the ocean floor for food. Sea otters have a broad diet of shellfish, [sea urchins](#), [crab](#), fish, and [snails](#). Otters use rocks, shells, and even discarded glass soda bottles as tools to help break open urchins and shellfish. They may eat up to one-quarter of their weight each day.



Annual productivity, or the amount of energy provided by the producers in this ecosystem, changes with the amount of upwelling. Kelp forests are one of the most productive ecosystems. During upwelling the productivity is off the chart. The average throughout the year is over 7000 kilocalories/square meter/year.

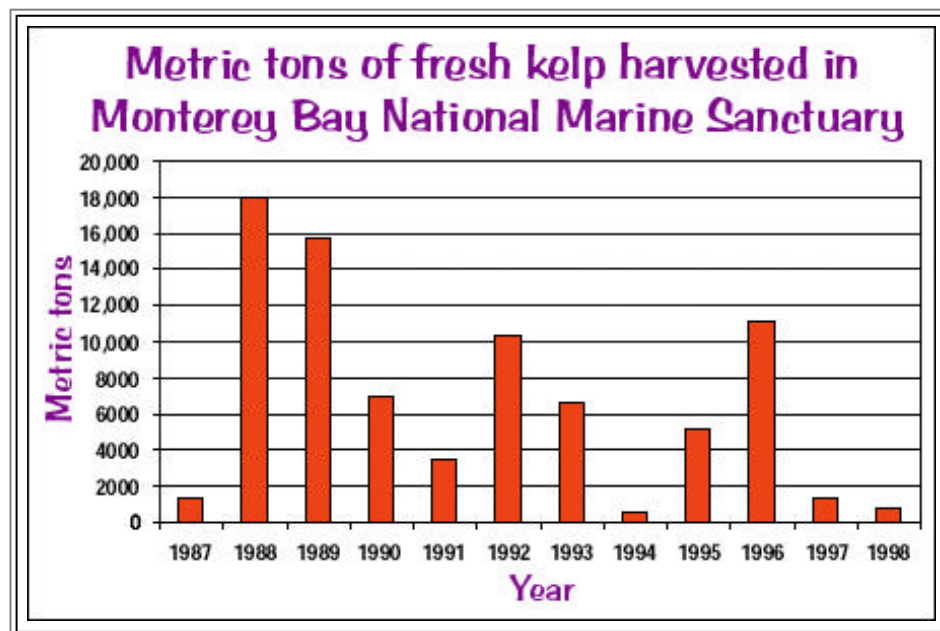


ISSUES

A primary concern for the kelp forest is the impact of fishing, kelp harvesting, and ocean farming or mariculture. People have used the oceans as a source for food for centuries, fishing and hunting for fish, invertebrates, whales, and other sea animals. Historically, fishing and hunting have had a significant impact on the kelp forest ecosystem.

Fishing

European traders reported the vast riches of the West Coast oceans in the 1700s. Many countries sent explorers and traders to reap the wealth of the kelp forest. The Chinese began harvesting [kelp](#), [abalone](#), squid, and shark in 1850. Italian immigrants fished and supplied the markets in San Francisco. By 1900, abalone was so scarce that commercial harvest was banned. Offshore fleets of fishing ships came from Japan, Russia, and Vietnam.



Monterey Bay is the location of Cannery Row, made famous in a book by John Steinbeck. The seemingly inexhaustible supply of sardines supported the local canning industry. In the 1940s and 1950s the sardine populations crashed, because of overharvesting and pollution.

The sardine population has not fully recovered from this crash. While over 3 million tons of sardines were harvested

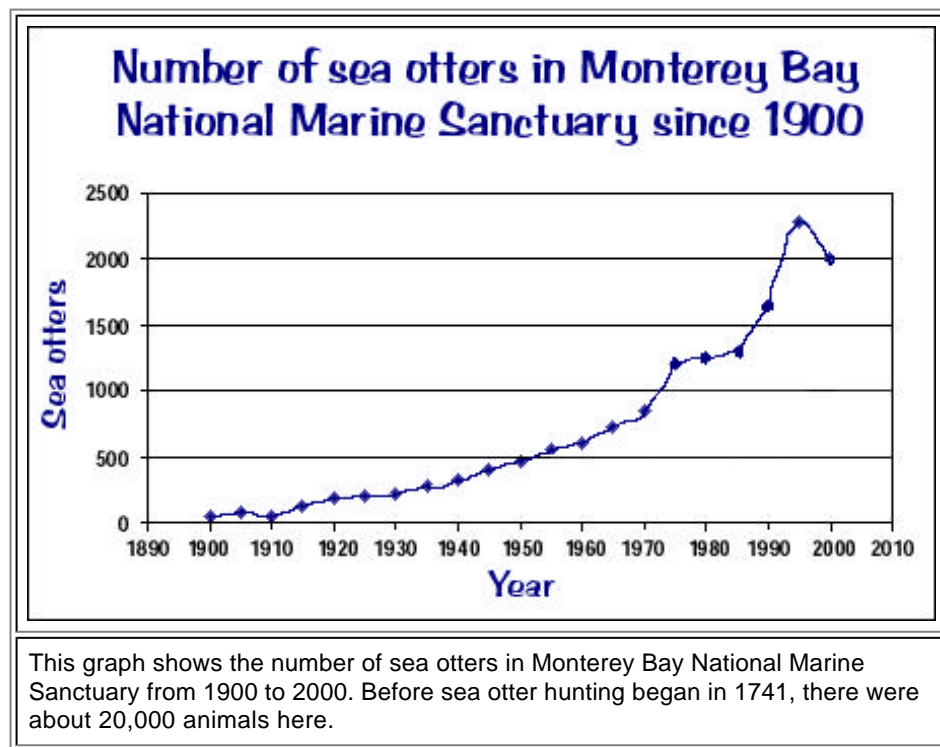
annually in the 1930s, only 5000 tons were caught each year in the 1970s. Regulations on sardine fishing have helped the population increase slowly since the mid-1980s.

Limited fishing and hunting still occur in Monterey Bay National Marine Sanctuary. Several organisms, including [kelp](#) and [abalone](#), are raised and harvested within the sanctuary. This method for farming the ocean is called mariculture.

Sea otters

Another concern was how the hunting of [sea otters](#) affected the kelp forest. Sea otters were hunted by Native Americans for thousands of years. In the mid-1700s Russia began hunting sea otters. Within 50 years the northern populations in Alaska were nearly eliminated. At about this time the Hudson Bay Company began hunting otters down the Pacific coast. By the 1920s only one colony existed south of Alaska, at Point Sur, California. The colony's location was kept secret by a small group of researchers. All the current California sea otters are descended from this colony.

As the otters disappeared from some areas, the kelp forests also disappeared. Researchers wondered if the hunting of sea otters was related to the disappearance of kelp forests. Sea otters eat [sea urchins](#), which in turn eat [kelp](#). With their predator gone, sea urchin populations grew. Large numbers of urchins grazed on kelp stipes and holdfasts, clearing large areas of kelp forest. New kelp was quickly eaten by sea urchins. These kelp-free areas patrolled by sea urchins are known as urchin barrens. When sea otters returned to these areas, the kelp forest thrived again.



While the sea otter population along the California coast had grown to almost 2400 in 1995, in the last few years it has been declining. Sea otters are having just as many pups, but pups and adults aren't surviving as well. There are several possible causes for this decrease. About 40% of the dead sea otters found appear to have died from disease, which could be caused by increased pollution. Tissue from some dead otters had high levels of pesticides and agricultural chemicals like DDT. Oil from spills penetrates the fur, making it impossible for the underfur to stay dry. Oil and other pollution affects the populations of sea otter prey, which could impact sea otter survival as well.

Accidents, such as being hit by a boat, are responsible for up to 20% of sea otter deaths. A few otters also die each year after becoming tangled in gill nets used by commercial fishers. Natural predators such as sharks also play a role. In Alaska, orca (killer whales) have recently been preying on sea otters.

Researchers don't fully understand why the number of sea otters is continuing to drop.

Giant kelp

Several species of [kelp](#) are harvested from Monterey Bay National Marine Sanctuary. Chinese immigrants harvested intertidal kelp in the 1850s, sending it back to China to be sold. The first large-scale harvest of kelp began during World War I. The kelp was burned and reduced to potash, a key ingredient in gunpowder.

Early methods of harvesting used cables to encircle large areas of kelp and pull it up. This pulled up everything on the ocean bottom and all the organisms living along the stipe. Today, kelp is harvested by cutting the stipes about 1.2 meters (4 feet) below the water's surface. The holdfast and most of the stipe remains intact. The kelp regrows quickly and can be cut again later.

Kelp is the source of algin. Algin is an additive that gives foods a smooth and creamy feel. It is found in pudding, salad dressing, tomato sauce, bakery icing, gravy, sauces, dietetic salad dressing, and milkshake powder.

Because the kelp forest ecosystem is so complex, it is hard to say how fishing, hunting, and mariculture may affect Monterey Bay National Marine Sanctuary. Giant kelp harvesting is of concern right now because it involves the dominant plant of kelp forests.

What has happened?

In October 2000 a scientific committee from Monterey Bay National Marine Sanctuary issued a report on kelp harvesting in the sanctuary. This report, which combines the findings of many scientists, makes recommendations about kelp harvesting. It suggests that some areas should have no mechanical harvesting, which would separate recreational and commercial uses of the kelp forests. It suggests that only giant kelp be harvested and that kelp harvesting should happen only in winter, since kelp have already finished annual reproduction by then. It also suggests reducing the amount of kelp cover removed. This would mean that a particular bed of kelp would not all be cut at the same time. Another suggested strategy is to allow more time for kelp forests to recover from cutting. Some of these suggestions could lead to a cycle of kelp abundance in specific beds. There would be "good kelp years" and "bad kelp years" as a result. Such a pattern would be difficult for abalone farmers, who need consistent access to kelp in order to keep their farms going.

THE DEBATE

Before making decisions that affect an ecosystem, it is important to gather information from a variety of sources. Below are the views of several individuals or groups that have an interest in the future of Monterey Bay National Marine Sanctuary. After each quote the hyperlink goes to the original source of the quote. Refer to these sites for more information.

Use the information provided to decide where you stand on this debate.

DEBATE: Should fishing and giant kelp harvesting be allowed in Monterey Bay National Marine Sanctuary?

People who support continuing fishing and kelp harvesting

Commercial fishing boat operator

"It's not the fishing industry that is causing a problem in the sanctuary. It's from all the pollution that runs off the agricultural areas. That is why the populations of some of the animals here are going down."

Water Quality Protection Program for Monterey Bay National Marine Sanctuary, Action Plan IV: Agriculture and Rural Lands

"The Sanctuary's watersheds receive rainfall, runoff from urban and rural lands, and return flows from irrigation which travel downhill to streams, rivers, wetlands, harbors and ultimately out to the Sanctuary. This runoff can pick up a variety of potential pollutants such as sediments, oils and grease, nutrients, pesticides, and pathogens, which can then be carried to the surrounding rivers and wetland areas that sustain many Sanctuary species."

http://montereybay.nos.noaa.gov/resourcepro/reports/AgactionIV_99/ag99_issues.html

Kelp harvester

"The sanctuary and NOAA issued a report that says kelp harvesting doesn't affect the kelp forest."

Monterey Bay National Marine Sanctuary, Kelp Management Report, October 2000

"The MBNMS Kelp Management Report discusses what is known about kelp harvesting in the MBNMS, as well as the known environmental impacts from the activity. This review concludes:

- When kelp harvesting is done on a limited scale, there is generally little detectable effect on the MBNMS kelp forest resources within the Sanctuary, and
- Few long-term studies exist that can determine the point at which intensive repetitious harvesting, especially in a

confined space, will begin to cause significant ecological impacts."

<http://montereybay.nos.noaa.gov/research/techreports/Kelpreportfinal/execsummary.html>

People who support further limitations on fishing and kelp harvesting

Pacific Grove resident

"It is important for us to preserve as much of the coastal environment as possible. Our town just erected signs to help people understand the importance of not disturbing the environment. Fishing disturbs the environment and should be limited."

Sandy Koffman, mayor of Pacific Grove

"The City of Pacific Grove is committed to protection and preservation of our shoreline and tidepools. We are grateful to the organizations and individuals who have contributed to the development of the new interpretative signs and research project, and we look forward to continued collaboration to improve public awareness and understanding of these magnificent and fragile resources."

http://www.mbnms.nos.noaa.gov/intro/press_releases/010208.html

Marine biologist

"Just because current kelp harvesting hasn't damaged the kelp forest, it doesn't mean that eventually it won't harm it."

Monterey Bay National Marine Sanctuary, Kelp Management Report, October 2000

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<http://montereybay.nos.noaa.gov/research/techreports/Kelpreportfinal/execsummary.html>

Questions

- Which side of this debate do you support?
- What scientific evidence supports your position?
- After looking at the evidence, did you change your position? Please explain why.

WEB LINKS

Monterey Bay National Marine Sanctuary - <http://montereybay.nos.noaa.gov/>

Anne Canright, Ocean 98, *Ocean Upwelling: So Cold, So Rich with Life* - <http://www.ocean98.org/cacoast2.htm>

California's Nearshore Waters and Open Ocean - <http://ceres.ca.gov/ceres/calweb/coastal/waters.html>

Kelp Watch - <http://www.kelpwatch.tas.gov.au/index.html>

Kelp Watch, Commercial Giant Kelp Harvesting - http://www.kelpwatch.tas.gov.au/h_c.html

Monterey Bay Aquarium - <http://www.mbayaq.org/>

Monterey Bay Aquarium Research Institute - <http://www.mbari.org/default.htm>

Monterey Bay National Marine Sanctuary, *Kelp Management Report*, October 2000 - <http://montereybay.nos.noaa.gov/research/techreports/Kelpreportfinal/welcome.html>

Monterey Bay National Marine Sanctuary, Site Characterization - <http://montereybay.nos.noaa.gov/sitechar/welcome.html>

Monterey Bay Sanctuary Foundation - <http://www.mbnmsf.org/>

National Oceanic and Atmospheric Administration, National Marine Sanctuaries - <http://www.sanctuaries.nos.noaa.gov/>

National Oceanic and Atmospheric Administration, *What Is an El Niño?* - <http://www.pmel.noaa.gov/tao/el-nino/el-nino-story.html>

Sandy Koffman, mayor of Pacific Grove - http://www.mbnms.nos.noaa.gov/intro/press_releases/010208.html

Trade and Environmental Database, *Sea Urchin Trade* - <http://www.american.edu/TED/urchin.htm>

Water Quality Protection Program for Monterey Bay National Marine Sanctuary, *Action Plan IV: Agriculture and Rural Lands, Water Quality Issues* - http://montereybay.nos.noaa.gov/resourcepro/reports/AgactionIV_99/ag99_issues.html
